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Abstract

Separation by countercurrent-exchange-electrolysis applied on lithiumisotopes

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Several applications of pure lithium isotopes are possible in the field of reactortechnology, e.g.

1) the use of lithium-7 as coolant in a nuclear reactor;
2) the application of ^{7}LiH or ^{7}LiD as moderator in a high temperature reactor;
3) the use of ^{7}LiF as solvent for nuclear fuels.

The separation of the lithium isotopes on a technical scale still constitutes a problem. According to recent publications separation by countercurrent-exchange-electrolysis is one of the rare methods, that might lead to acceptable results.

Thus far literature on this subject is rather poor. Besides a French patent, which appeared in 1959, we only found a paper of Lewis and Macdonald dated back as far as 1936. Letting descend fine droplets of amalgam through an ascending solution of lithiumchloride Lewis and Macdonald obtained a noticeable separation in a column with a length of 18m and only 4mm wide. From this paper it appears that the maintenance of the necessary zigzag movement of the amalgam droplets is a severe problem prohibiting technical application.

Recent work, done in our Institute on packed columns, lead to more promising results. When a column containing sand with a particle size of 0.35-0.5 mm is properly treated, it permits a countercurrent transport of lithiumamalgam and a solution of lithiumchloride in dimethylformamide.

The reflux at the bottom of the column, where the lithium is transported from the amalgam to the electrolyt solution (anodic reflux), has been realised by a new continuous method based on exchange-electrolysis. The cathodic reflux

is obtained by evaporating the solvent dimethylformamide, transferring the lithiumchloride into water and electrolysing the lithiumchloride solution in water.

Experiments carried out during 20 to 40 hours in an exchange column with a length of 1 to 2 m, resulted in an increase of lithium-6 content from 7.5 till 12.0 % at the bottom of the column and a decrease of lithium-6 content from 7.5 till 5.8 % at the top of the column as appeared from mass-spectrographic analysis (these data correspond with separation factors of 1.68 and 0.76, whereas the elementary separation-factor amounts to 1.05).

The application of the method to be presented is not restricted to the separation of the lithium isotopes. It also offers possibilities for the separation of the calcium isotopes and for the reprocessing of a liquid metal reactor fuel like a solution of uranium in molten bismuth.

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Abstract

New Aspects in the Application of Collision Probabilities in Reactor Theory

by

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During the past few years several computational methods involving the application of collision probabilities have been developed at the Siemens Reactor Department with the objective of basing the lattice calculational program on a common collision probability concept. The paper reviews these methods and describes some recent developments. In particular, it deals with problems associated with neutron spectra and physical lattice properties of heterogeneous media.

1. Starting from the integral transport equation describing the neutron flux as a function of space and energy, a set of N coupled integral equation is derived by subdividing the unit cell into N regions and introducing first-flight collision probabilities. By treating e.g. the integral expressions in an approximate manner the well known Wilkins thermalization theory for homogeneous media is extended to heterogeneous media. The resulting theory is reduced to a form which is readily accessible to numerical solution. The method is applied to some cases of practical interest.

   Similarly, on applying the above concept to the fast and epithermal energy region, the slowing-down calculational methods known as Greuling-Goertzel, Selengut-Goertzel and Fermi-Age approximations

can be readily generalized to heterogeneous lattice cells.

2. An alternate method of formulating neutron balance equations for a heterogeneous medium applies the concept of multiple collision probabilities.

   This leads to a generalization of Amouyal's and Benoist's (A & B) method for calculating the thermal utilization of a lattice cell. The outermost cell region can be treated either by diffusion theory (A & B) or integral transport theory.

   This method is further extended by introducing more than one energy group which results in a practical procedure for calculating the fast fission effect, taking into account back-scattering and fast interaction effects. - Theoretical results are found to be in very satisfactory agreement with experiments.

3. The practical applicability of all the afore-mentioned collision probability methods depends sensitively on the availability of methods adequate for calculating these collision probabilities to a reasonable accuracy. Simplified methods for computing these quantities, developed in the Siemens Reactor Department, are reviewed and discussed with regard to their accuracy.